Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Engine Harmonization Working Group

Task 4 – Rotor Integrity

Task Assignment

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Subcommittee; Propulsion Harmonization Working Group

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of establishment of Propulsion Harmonization Working Group.

SUMMARY: Notice is given of the establishment of the Propulsion Harmonization Working Group of the Transport Airplane and Engine Subcommittee. This notice informs the public of the activities of the Transport Airplane and Engine Subcommittee of the Aviation Rulemaking Advisory Committee.

FOR FURTHER INFORMATION CONTACT: Mr. William J. (Joe) Sullivan, Executive Director, Transport Airplane and Engine Subcommittee, Aircraft Certification Service (AIR–3), 800 Independence Avenue SW., Washington, DC 20591, Telephone: (202) 267–9554; FAX: (202) 267–5364.

SUPPLEMENTARY INFORMATION: The Federal Aviation Administration (FAA) established an Aviation Rulemaking Advisory Committee (56 FR 2190, January 22, 1991) which held its first meeting on May 23, 1991 (56 FR 20492, May 3, 1991). The Transport Airplane and Engine Subcommittee was established at that meeting to provide advice and recommendations to the Director, Aircraft Certification Service, FAA, regarding the airworthiness standards for transport airplanes, engines and propellers in parts 25, 33, and 35 of the Federal Aviation Regulations (14 CFR parts 25, 33, and 35).

The FAA announced at the Joint Aviation Authorities (JAA)—Federal Aviation Administration (FAA) Harmonization Conference in Toronto, Ontario, Canada, (June 2–5, 1992) that it would consolidate within the Aviation Rulemaking Advisory Committee structure an ongoing objective to "harmonize" the Joint Aviation Requirements (JAR) and the Federal Aviation Regulations (FAR). Coincident with that announcement, the FAA assigned to the Transport Airplane and Engine Subcommittee those projects related to JAR/FAR 25, 33, and 35 harmonization which were then in the process of being coordinated between the JAA and the FAA. The harmonization process included the intention to present the results of JAA/FAA coordination to the public in the form of either a Notice of Proposed Rulemaking or an advisory circular—an objective comparable to and compatible with that assigned to the Aviation Rulemaking Advisory Committee. The transport Airplane and Engine Subcommittee, consequently, established the Propulsion Harmonization Working Group.

Specifically, the Working Group's tasks are the following: The Propulsion Harmonization Working Group is charged with making recommendations to the Transport Airplane and Engine Subcommittee concerning the FAA disposition of the following subjects recently coordinated between the JAA and the FAA:

Task 1—Bird Ingestion: Update turbine engine bird ingestion requirements, including size and number of birds and pass/fail criteria (FAR 33.77)

Task 2—Inclement Weather: Update the inclement weather requirements for rain and hail in turbine engines (FAR 33.77).

Task 3—Vibration Surveys: Determine test requirements and pass/Fail criteria for turbine engine vibration tests (FAR 33.83).

Task 4—Rotor Integrity: Determine test requirements and pass/fail criteria for turbine, compressor, fan, and turbosupercharger rotor overspeed tests (FAR 33.27).

Task 5—Turbine Rotor Overtemperature: Clarify test and pass/fail requirements for turbine engine overtemperature tests to assure consistent certification criteria (FAR 33.88).

Task 6—Windmilling: Exmaine current turbine engine windmilling requirements and specify appropriate test and analysis requirements (FAR 33.92).

Reports:

A. Recommend time line(s) for completion of each task, including rationale, for Subcommittee consideration at the meeting of the subcommittee held following publication of this notice.

B. Give a detailed conceptual presentation on each task to the Subcommittee before proceeding with the work stated under items C and D, below. If task 1–6 require the development of more than one Notice of Proposed Rulemaking, identify what proposed amendments will be included in each notice.

C. Draft a Notice of Proposed Rulemaking for tasks 1–6 proposing new or revised requirements, a supporting economic analysis, and other required analysis, with any other collateral documents (such as Advisory Circulars) the Working Group determines to be needed.

D. Give a status report on each task at each meeting of the Subcommittee.

The Propulsion Harmonization Working Group will be comprised of experts from those organizations having an interest in the tasks assigned. A working Group member need not necessarily be a representative of one of the organizations of the parent Transport Airplane and Engine Subcommittee or of the full Aviation Rulemaking Advisory Committee. An individual who has expertise in the subject matter and wishes to become a member of the Working Group should *write* the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire, describing his or her interest in the task, and the expertise he or she would bring to the Working Group. The request will be reviewed with the Subcommittee and Working Group Chairs and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the information and use of the Aviation Rulemaking Advisory Committee and its subcommittees are necessary in the public interest in connection with the performance of duties of the FAA by law. Meetings of the full Committee and any subcommittees will be open to the public except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the Propulsion Harmonization Working Group will not be open to the public except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of Working Group meetings will be made.

Issued in Washington, DC, on December 4, 1992.

William J. Sullivan,

Executive Director, Transport Airplane and Engine Subcommittee, Aviation Rulemaking Advisory Committee.

[FR Doc. 92–30113 Filed 12–10–92; 8:45 am]

BILLING CODE 4910–13–M

Recommendation

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 1 and 33

[Docket No. XXXXX; Notice No. XX-XXX]

RIN NO. 2120-XXXX

Airworthiness Standards; Aircraft Engine Standards Overtorque Limits

AGENCY: Federal Aviation Administration (FAA) DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This notice proposes to amend the certification standards for original and amended type certificates for aircraft engines and would introduce standards for maximum overtorque by adding a new engine overtorque test, amending engine ratings and operating limitations, and amending the general definitions. The proposed rule, if adopted, would establish nearly uniform standards for overtorque design and tests for turbopropeller and turboshaft engines that incorporate free power-turbines, certificated in the United States under 14 CFR part 33 and by the Joint Aviation Authorities (JAA) under the Joint Airworthiness Requirements – Engines (JAR-E).

DATE: Send your comments on or before [Insert date 90 days after the date of publication in the Federal Register].

ADDRESSES: You may send comments, identified by the Docket Number *FAA-200X-XXXXX,* using any of the following methods:

- DOT Docket web site: Go to http://dms.dot.gov and follow the instructions for sending your comments electronically.

- Government-wide rulemaking web site: Go to http://www.regulations.gov and follow the instructions for sending your comments electronically.
- Mail: Docket Management Facility; US Department of Transportation, 400 Seventh Street, S.W., Nassif Building, Room PL-401, Washington, DC 20590-001.
- Fax: 1-202-493-2251.
- Hand Delivery: Room PL-401 on the plaza level of the Nassif Building, 400 Seventh Street, S.W., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

For more information on the rulemaking process, see the SUPPLEMENTARY INFORMATION section of this document.

Privacy: We will post all comments we receive, without change, to http://dms.dot.gov, including any personal information you provide. For more information, see the Privacy Act discussion in the SUPPLEMENTARY INFORMATION section of this document.

Docket: To read background documents or comments received, go to http://dms.dot.gov at any time or to Room PL-401 on the plaza level of the Nassif Building, 400 Seventh Street, S.W., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Tim Mouzakis, Engine and Propeller Standards Staff, ANE-110, Engine and Propeller Directorate, Aircraft Certification Service, Federal Aviation Administration (FAA), New England Region, 12 New England Executive Park, Burlington, Massachusetts 01803-5299; telephone (781) 238-7114; fax (781) 238-7199; electronic mail "Timoleon.Mouzakis@faa.gov".

SUPPLEMENTARY INFORMATION:

Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. We also invite comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. We ask that you send us two copies of written comments.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the ADDRESSES section of this preamble between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. You may also review the docket using the Internet at the web address in the ADDRESSES section.

Privacy Act: Using the search function of our docket web site, anyone can find and read the comments received into any of our dockets, including the name of the individual sending the comment (or signing the comment on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the Federal Register published on April 11, 2000 (65 FR 19477-78) or you may visit http://dms.dot.gov.

Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring expense or delay. We may change this proposal in light of the comments we receive.

If you want the FAA to acknowledge receipt of your comments on this proposal, include with your comments a pre-addressed, stamped postcard on which the docket number appears.

We will stamp the date on the postcard and mail it to you.

Availability of Rulemaking Documents

You can get an electronic copy using the Internet by:

(1) Searching the Department of Transportation's electronic Docket Management System (DMS) web page (http://dms.dot.gov/search);

(2) Visiting the Office of Rulemaking's web page at http://www.faa.gov/avr/arm/index.cfm; or

(3) Accessing the Government Printing Office's web page at http://www.access.gpo.gov/su_docs/aces/aces140.html.

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue S.W, Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

Background

Part 33 of Title 14 of the Code of Federal Regulations (14 CFR part 33) prescribes airworthiness standards for original and amended type certificates for aircraft engines. The Joint Aviation Requirements-Engines (JAR-E) prescribes corresponding airworthiness standards for the certification of aircraft engines by the Joint Aviation Authorities (JAA). While part 33 and JAR-E are similar, they differ in several respects. For applicants seeking certification under both part 33 and JAR-E, these differences result in additional costs and delays in the time required for certification.

The FAA is committed to undertaking and supporting the harmonization of part 33 and the JAR-E requirements. In August 1989, the FAA Engine and Propeller Directorate participated

in a meeting with the JAA, Aerospace Industries Association (AIA), and The European Association of Aerospace Industries (AECMA). The purpose of the meeting was to establish a philosophy, guidelines, and a working relationship regarding the resolution of issues identified as needing to be harmonized, including some where new standards are needed. All parties agreed to work in a partnership to jointly address the harmonization effort task. This partnership was later expanded to include Transport Canada, which is the airworthiness authority of Canada.

This proposal has been selected as an Aviation Rulemaking Advisory Committee (ARAC) project. This task was assigned to the Engine Harmonization Working Group (EHWG) of the Transport Airplane and Engine Issues Group (TAEIG) and notice of the task was published in the Federal Register on October 20, 1998 (63 FR 56059). On August 25, 1999, the TAEIG recommended to the FAA that it proceed with the rulemaking. This proposed rule reflects the ARAC recommendations.

Discussion of the Proposed Rule

Currently the FAA has no explicit standards in part 33 for approval of a maximum overtorque limit. Engine manufacturers have obtained FAA approvals of maximum overtorque limit based on other certification engine tests and analysis that did not directly address considerations for maximum overtorque limit, and allowed for different interpretations of the data by different FAA offices. The proposed rule would establish a single standard for all FAA offices to use in approving maximum overtorque limit. In addition, because the JAR-E does contain specific standards for the approval of maximum overtorque limits, US aircraft engine manufacturers face additional costs when seeking certification of their engine designs by the JAA for export.

The proposed rule would nearly harmonize with the JAR-E 820 approach for approving

engine overtorque transients, and would apply only to turbopropeller and turboshaft engines incorporating free power-turbines. The proposed rule would not, however, use the current JAR-E 820 wording but would contain changes to clarify the requirements, and would provide that an overtorque limit associated with operation at the 30-second and 2-minuteOEI ratings is not permitted.

This rule is being adopted to address a condition that can occur on turbopropeller and turboshaft engines with free power turbines. Sudden large changes in rotorcraft/aircraft blade pitch, or power demand, such as an engine failure on a twin engine rotorcraft, can cause a large decrease in rotor/propeller speed. For rotorcraft engine, overtorque conditions may occur during the period that the engine is accelerating the rotor system back to normal operating speeds. This rule prescribes the requirements to establish a maximum transient (20 seconds maximum) overtorque limit.

The following paragraph provides clarification to the test requirement of paragraph (b)(4) in the proposed rule regarding maximum turbine entry temperature.

The torque transmitting components in a free turbine engine are typically the turbine blades, wheels, shafts, and gears (if an internal gearbox exists). Torque has differing effects on the stress levels in these components. For example, the stresses in turbine blades and wheels are dominated by centrifugal loads (and to a lesser extent, by temperature) and the effects of gas loads producing torque have a minor effect on total stress in these components. The stress levels of components such as shafts and gears are typically dominated by the amount of torque they are transmitting. Turbine entry temperatures generally have little effect on the stress levels in shafts and gears. Typically the time spent at maximum steady state temperature and high speed during the § 33.87 endurance test results in higher turbine blade and disc stresses than would occur

during a maximum overtorque event. Therefore, when the evidence of the § 33.87 testing could be used to provide the substantiation, the requirement to run the § 33.84 test at maximum steady state temperature maybe waived.

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. We have determined that there are no new information collection requirements associated with this proposed rule.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations.

Executive Order 12866 and DOT Regulatory Policies and Procedures

Executive Order 12866, Regulatory Planning and Review, directs the FAA to assess both the costs and benefits of a regulatory change. We are not allowed to propose or adopt a regulation unless we make a reasoned determination that the benefits of the intended regulation justify the costs. Our assessment of this proposal indicates that its economic impact is minimal because the proposed rules, if adopted, would establish nearly uniform standards for overtorque design and tests for turbopropeller and turboshaft engines that incorporate free power-turbines, certificated in the United States under 14 CFR part 33 and by the Joint Aviation Authorities (JAA) under the Joint Airworthiness Requirements – Engines (JAR-E). Because the costs and

benefits do not make it a "significant regulatory action" as defined in the Order, we have not prepared a "regulatory evaluation," which is the written cost/benefit analysis ordinarily required for all rulemaking proposals under the DOT Regulatory Policies and Procedures. We do not need to do a full evaluation where the economic impact of a proposed rule is minimal.

By directly addressing maximum overtorque limits for the affected turbines, the proposed rule is expected to bring about cost savings by (1) reducing manufacturers' administrative and analysis expenses associated with successive requests for the determination of overtorque limits, (2) establishing a single set of performance standards for the affected turbines, rather than allowing the development of multiple standards, which may result in duplicative efforts by various FAA offices, and (3) avoiding the costs incurred by manufacturers who may have to carry out more than one test in order to establish an engine's conformance with both FAA and JAA regulations. Since the proposed rule both clarifies requirements, and was supported in the EHWG by representatives of the affected engine manufacturers, it is expected to either reduce costs or impose no net costs on aircraft engine manufacturers.

The proposed rule is expected to maintain the current level of safety.

Since the rule is expected to have no effect on the level of safety, and provide benefits to manufacturers and the FAA by avoiding potential costs that could result from the existence of differing certification requirements, the proposed rule is expected to be cost-beneficial. The FAA invites comments on the effects of this proposed regulation, and, in particular, would appreciate relevant quantitative data, if available.

Economic Assessment, Regulatory Flexibility Determination, Trade Impact Assessment, and Unfunded Mandates Assessment

Proposed changes to Federal regulations must undergo several economic analyses. First,

Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. §§ 2531-2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act also requires agencies to consider international standards and, where appropriate, use them as the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by private sector, of $100 million or more annually (adjusted for inflation).

In conducting these analyses, FAA has determined this rule (1) has benefits that justify its costs, is not a "significant regulatory action" as defined in section 3(f) of Executive Order 12866, and is not "significant" as defined in DOT's Regulatory Policies and Procedures; (2) will not have a significant economic impact on a substantial number of small entities; (3) will not reduce barriers to international trade; and (4) does not impose an unfunded mandate on state, local, or tribal governments, or on the private sector. These analyses, available in the docket, are summarized below.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) directs the FAA to fit regulatory requirements to the scale of the business, organizations, and governmental jurisdictions subject to the regulation. We are required to determine whether a proposed or final action will have a

"significant economic impact on a substantial number of small entities" as they are defined in the Act. If we find that the action will have a significant impact, we must do a "regulatory flexibility analysis."

This proposed rule, if adopted, would establish nearly uniform standards for overtorque design and tests for turbopropeller and turboshaft engines that incorporate free power-turbines, certificated in the United States under 14 CFR part 33 and by the Joint Aviation Authorities (JAA) under the Joint Airworthiness Requirements – Engines (JAR-E). Therefore, we certify that this action will not have a significant economic impact on a substantial number of small entities.

Trade Impact Analysis

The Trade Agreement Act of 1979 prohibits Federal agencies from establishing any standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this rulemaking and has determined that it will accept the European standards as the basis for U.S. regulations and support the Administration's policy on free trade.

Unfunded Mandates Reform Act.

The Unfunded Mandates Reform Act of 1995 (the Act) is intended, among other things, to curb the practice of imposing unfunded Federal mandates on State, local, and tribal governments. Title II of the Act requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in

an expenditure of $100 million or more (adjusted annually for inflation) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action."

This NPRM does not contain such a mandate. The requirements of Title II of the Act, therefore, do not apply.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. The FAA has determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government, and therefore would not have federalism implications.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this rulemaking action qualifies for a categorical exclusion.

Energy

The energy impact of the notice has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) P.L. 94-163, as amended (43 U.S.C. 6362) and FAA Order 1053.1. We have determined that the notice is not a major regulatory action under the provisions of the EPCA.

List of Subjects 14 CFR Part 1

Flights, Transportation, Air Safety, Safety, Aviation Safety, Air Transportation, Aircraft,

Airplanes, helicopters, Rotorcraft, Heliports, Engines, Ratings.

List of Subjects in 14 CFR Part 33

Air transportation, Aircraft, Aviation safety, Safety.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend parts 1 and 33 of Title 14, Code of Federal Regulations (14 CFR parts 1 and 33) as follows:

PART 1 - DEFINITIONS AND ABBREVIATIONS

1. The authority citation for part 1 continues to read as follows:

Authority: 49 USC 106(g), 40113, 44701.

2. Section 1.1 is amended by adding the definition in alphabetical order of "Maximum engine overtorque" to read as follows:

§ 1.1 General definitions

* * * * *

Maximum engine overtorque (applicable only to turbopropeller and turboshaft engines incorporating free power-turbines for all ratings except OEI ratings of two minutes or less) means the maximum torque of the free power-turbine, inadvertent occurrence of which, for periods of up to 20 seconds, will not require rejection of the engine from service, or any maintenance action other than to correct the cause.

* * * * *

PART 33 - AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

3. The authority citation for part 33 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701-44702, 44704

4. Section 33.7 is amended by adding new paragraph (c)(17), and new § 33.84 to read as

follows:

§ 33.7 Engine ratings and operating limitations.

* * * * *

(c) * * *

(17) Maximum engine overtorque for turbopropeller and turboshaft engines incorporating free power-turbines.

§ 33.84. Engine Overtorque Test

(a) If approval of a maximum engine overtorque is sought for an engine incorporating a free power turbine, compliance with this paragraph must be demonstrated by test.

(1) The test may be run as part of the endurance test required by § 33.87 of this part.

Alternatively, tests may be performed on a complete engine or on individual groups of components provided they are shown to be equivalent.

(2) Upon conclusion of such tests, each engine part or individual groups of components shall meet the requirements of § 33.93(a)(1) and (a)(2) of this part.

(b) The test conditions must be as follows:

(1) A total of 15 minutes run at the maximum engine overtorque to be approved. This may be done in separate runs, each being of at least 2 ½ minute's duration.

(2) A power turbine rotational speed equal to the highest speed at which the maximum overtorque can occur in service. The test speed shall not be more than the limit speed of take-off or OEI ratings longer than 2 minutes, whichever is higher.

(3) For engines incorporating a reduction gearbox, a gearbox oil temperature equal to the maximum temperature at which the maximum overtorque could occur in service; and for all other engines, an oil temperature within the normal operating range.

(4) A turbine entry gas temperature equal to the maximum steady state temperature approved for use during periods longer than 20 seconds, other than conditions associated with 30-second or 2-minutes OEI ratings. The requirement to run the test at the maximum approved steady state temperature may be waived if it can be shown that other testing provides substantiation of the temperature effects when considered in combination with the other parameters identified in paragraphs (b)(1), (b)(2) and (b)(3) of this section.

Issued in Washington, DC, on

Turbine, compressor, fan, and turbosupercharger rotors
DRAFT ADVISORY CIRCULAR

Revision: **Rev 3**

Date: **16 August, 1998**

File: **riac3.doc**

Subject: Overspeed requirements **Initiated by ANE-110** **AC No. 33.27-1**

1. PURPOSE. This advisory circular (AC) provides definitions, guidance, and acceptable methods, but not the only methods, that may be used to demonstrate compliance with the overspeed requirements of part 33, section§33.27, of the Federal Aviation Regulations. The content of this AC may be incorporated into the Aircraft Engine Type Certification Handbook at a later date.

2. RELATED SECTIONS OF THE FEDERAL AVIATION REGULATIONS.

Related Sections are 33.14, 33.75 and 33.19.

3. BACKGROUND. The subject of overspeed (rotor integrity) requirements was identified as one where differences existed between the Joint Aviation Requirements - Engines (JAR-E) and part 33 of the Federal Aviation Regulations. A study group composed of representatives of the Federal Aviation Administration (FAA), the Joint Aviation Authorities (JAA), Transport Canada and Industry worked to produce a set of improved and harmonized overspeed requirements that was subsequently incorporated into part 33 (as a revision of Section 33.27). This AC is intended to provide guidance relating to these revised requirements.

4. DEFINITIONS. For the purposes of this AC, the following definitions apply:

(a) Rotor

Individual stage of a fan, compressor or turbine assembly (some assemblies may consist of only one stage).

(b) Sample Rotor

A test article or assembly including, where appropriate, coverplates, spacers, etc. that is representative of the standard to be certified and for which the material properties and dimensions are known.

(c) Extremely Improbable

The term extremely improbable means failure conditions having an average probability of occurrence not more than 1.0E-9 per hour of engine operation.

(d) Maximum Permissible Speed

Maximum permissible rotor speed is the maximum approved speed, including transients, for the relevant rating.

5. INTENT. The safety objectives of the overspeed requirements are, (1) designing rotors with a margin to burst above certified operating conditions and above failure conditions leading to rotor overspeed, and (2) not to have a level of growth or damage which will lead to a hazardous condition..

6. GENERAL.

(a) The demonstration of compliance with the safety objectives of paragraphs 33.27(a) and (d) may be made separately or be combined, as described in this advisory material._

(b) Paragraphs 33.27(a) and (d) allow various means of compliance ("tests, analysis or a combination") in order to meet the objectives identified. It is the applicant's responsibility to propose the appropriate means of compliance, in accordance with the guidelines defined in this AC.

(c) Any analysis approach allowed under §33.27 should be defined and validated before usage.

(d) The applicant should submit to the authority the appropriate analysis to determine which of the conditions in paragraph 33.27 (b) is the most critical for each individual rotor stage with respect to the requirements of paragraph 33.27(a). A similar analysis should be submitted with respect to the requirements of paragraph 33.27(d).

Where the peak overspeed is limited by deliberate blade shedding:

(i) the conditions of paragraphs 33.27(b)(3) and (b)(4) nevertheless apply to a fully bladed rotor at that speed, and

(ii) the analysis to determine the most critical speed with respect to rotor integrity should consider this function throughout the flight envelope. Consideration should be given to the blade failure speed taking into account tolerance effects, temperature and material property variations of the blades together with the most adverse combination of the tolerance effects and material properties on the integrity of the rotor. Consequently the most critical speed with respect to rotor integrity might not be coincident with the highest achievable blade shedding speed.

(e) While considering the most adverse combination of dimensional tolerances and material

properties, as required in paragraphs 33.27 (a) and (d), the applicant should also consider the tolerances and material properties of blades, overspeed limiter, etc., adversely influencing stress levels in the rotor.

(f) Failure conditions which are of a sudden transient nature (reference paragraphs 33.27(a) & (d)) are typified by loss of load failures, i.e., characterized by high rates of acceleration and deceleration with no dwell period at the highest overspeed attained.

The applicant should also examine all possible failure conditions to determine if any case exists which would result in a dwell period at speeds close to that of the

transient short duration failure condition. If such a case exists, the applicant should determine which condition is the most critical with respect to rotor integrity.

(g) The appropriate percentage speed factor of paragraph 33.27 (b) should be applied after making the necessary speed adjustments for temperatures, material properties, tolerance effects, etc. The necessary speed adjustments for temperature and material properties will normally be established on the basis of appropriate ratios of material properties.

(h) The consequences of rotor growth sufficient to cause significant contact or displacement between engine components should be assessed to determine that the requirements of paragraph 33.27 (d)(1) can be met.

(i) When determining compliance with the requirements of paragraph 33.27 (d)(2) the applicant should consider whether or not the rotor would exhibit any condition that would be likely to prevent the safe operation of the engine for a period of time that could occur in service following any failure or combination of failures considered under paragraphs 33.27 (b)(3) or (b)(4). This period of time might be equal to that required to recognize the event and shut the engine down, or to that required for continued safe flight and landing. The length of time might also depend upon the operational instructions for an overspeed event.

(j) Where a number of rotors are of similar design, are made of materials to the same specification and are subjected to similar stress conditions, temperature levels and gradients, it is permissible for compliance with paragraph 33.27 (a) to test only the most critical rotor, with respect to burst. This would require determination of the burst speed for each rotor in order to select the most critical which is assumed to have the smaller margin to burst above the speeds specified in paragraph 33.27 (b).

The most adverse combination of temperatures and temperature gradients which is possible throughout the entire operating envelope may vary for individual rotors in an assembly.

The most critical rotor with respect to burst might not be the most critical with respect to growth. Consideration should be given to the components surrounding each rotor in order to determine the most critical rotor with respect to growth for compliance with §33.27 (d).

(k) Appropriate tests or analysis based on tests should establish the burst speed of each fan, compressor, and turbine rotor design in relation to the most critical condition prescribed in §33.27 (b) and this should be reported in the certification documentation. These burst speeds should be based on the most adverse combination of dimensional tolerances and material properties.

(l) For a multi stage rotor in which the rotors do not meet the conditions of similarity as described in paragraph (5)(j) above, the compliance of each rotor stage with §33.27 should be substantiated using representative test data.

7. ACCEPTABLE MEANS OF COMPLIANCE MAY INCLUDE.

(a) Testing a sample rotor on a rig or engine at the conditions necessary to demonstrate that a minimum strength rotor would meet the requirements of paragraphs 33.27 (a) and (d).

(b) Where the conditions of paragraphs 33.27 (b) (1) or (b)(2) are the most critical, testing a sample rotor for the required period of time in an engine at not less than 96% of the speed necessary to demonstrate that a minimum strength rotor would meet the requirements of paragraphs 33.27 (a) and (d) provided that this resultant reduced test condition is not less severe than that required to demonstrate compliance with paragraphs 33.27(b)(3) and (b)(4) and, it is shown from a validated method of burst prediction that burst would not have occurred at the conditions of paragraphs 33.27(b) (1) or (b)(2).

(c) An analytical modeling method based on representative test data may be acceptable provided that:

(i) the model has been validated by comparison with results from specimen and rotor tests and

(ii) its use is limited to rotors with material, geometry, stress, and temperature conditions encompassed by those used to construct the model and

(iii) the predictions show that the certification standard rotor is not more critical, with respect to burst and growth, than any similar rotor for which substantiation has been demonstrated both by rotor test and model prediction.

(d) Any test may be continued to rotor burst after the required time duration by increasing the speed until the rotor bursts. If the applicant chooses this method, then it should be shown that :

(i) The sample rotor was initially run at conditions not less severe than those required for compliance with paragraph 33.27 (a), and

(ii) Paragraph 33.27 (d) can be complied with using an approved analytical modeling method.

(e) The engine control devices, systems and instruments referred to in paragraph 33.27(e) is usually provided in modern engines by overspeed protection and or circuits which although they may be provided as independent devices, are

generally provided as part of the electronic engine control (EEC) system. One acceptable method for showing compliance with the requirement for "reasonable assurance" of providing functionality of the protection systems or circuits is to have them be tested by a built-in test equipment (BITE) test, or a periodic functional test.

In the case of the overspeed protection system, the BITE test should provide 100% test of the electrical/electronic part of the protection system. The mechanical or actuating part of the overspeed system can be demonstrated to be functional over a periodic inspection period.

8. FACTORS TO BE CONSIDERED WHEN DETERMINING TEST CONDITIONS.

(a) Temperature

The rotor temperatures required by paragraph 33.27 (b) are:

(i) for paragraphs 33.27 (b) (1) and (b)(2) the material temperatures and temperature gradients equal to the most adverse which could be achieved when operating in the engine at the required rating condition.

(ii) for paragraphs 33.27 (b)(3) and (b)(4) the material temperatures and temperature gradients equal to the most adverse which could be achieved

when operating in the engine at the required rating condition immediately prior to the failure(s).

These temperatures and temperature gradients should be established by temperature surveys on an engine, or derived by a validated analysis. Adjustments of test speed or blade mass or both should be applied to compensate for any deviation from the required temperatures and temperature gradients.

(b) Sample Rotor Material Properties

Material properties of the sample rotor may be determined from attached test rings/bars when the correlation of their properties has been established by a validated method using coupons obtained from forgings/castings of the type to be approved.

When attached test rings/bars are not available to determine the material properties of the sample rotor, a value for the material properties may be established by assuming that the sample rotor possesses material properties equal to known average properties of similar rotors from the same manufacturing process lot if it can be shown that the assumption is valid within acceptable confidence limits.

9. FAILURE CASES.

In order to determine the highest overspeed resulting from a loss of load to be considered under §33.27 (c), it will be necessary to consider, for possible failure locations, such factors as system inertia, available gas energy, whether the rotor is held in plane, overspeed protection devices, etc.. With respect to combinations of failures, at any rating, it is considered that if the likelihood of a combination is very low (1.0E-9 or less) the case need not be considered.

Table of References

1. FAA Advisory Circular, AC 33.2B, Aircraft Engine Type Certification Handbook

2. FAA Advisory Circular, AC 33.3, Turbine and Compressor Rotor Type Certification Substantiation Procedures

FAA Action – Not Available